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FOR
APPARATUS AND METHOD FOR INJECTING SYNCHRONIZED STREAM DATA IN
DIGITAL BROADCASTING ENVIRONMENT

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APPARATUS AND METHOD FOR INJECTING SYNCHRONIZED STREAM
DATA IN DIGITAL BROADCASTING ENVIRONMENT

Field of the Invention

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The present invention relates to an apparatus and method for injecting synchronized stream data into a Moving Picture Experts Group 2 (MPEG-2) video/audio transport stream (TS) for a digital data broadcasting service.

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Description of Related Art

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A digital broadcasting service has an advantage that diverse multimedia data could be transmitted along with video/audio data. The data that may be provided in a digital broadcasting service includes asynchronous data, synchronous data, synchronized data which are discriminated based on the temporal relationship with video/audio data.

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The asynchronous data are those that can be presented independently regardless of video/audio data. The asynchronous data may be used for providing services, such as weather forecast, news, securities reports and the like. In the meantime, most of the data broadcasting services practically used in Korea and other countries are asynchronous data services of a data carousel type. In data carousel type of data service, the asynchronous data is periodically injected into an MPEG-2 video/audio transport stream and

transmitted to a receiver. The transmitted data are executed in the receiver upon the request of a user.

Synchronous data use MPEG-2 program clock reference (PCR) and MPEG-2 presentation time stamp (PTS) to temporally
5 restrict the data presented in the receiver.

Synchronized data are presented in connection with video/audio data. They use MPEG-2 PCR and MPEG-2 PTS to coincide the presentation time stamps of their data access units (DAU) and the access units (AUs) of another stream.
10 Synchronized data have two types based on the continuity of data presentation: stream data and non-stream data.

First, synchronized non-stream data are those presented only once at a particular time point of video/audio data. Information on a baseball player appearing at the bat, or
15 information on a place shown up in a particular scene of a soap opera should be presented only once in connection with video data, it can be provided in the form of synchronized non-stream data.

Synchronized stream data are those data that should be presented successively in connection with video/audio data.
20 MPEG video data or MPEG audio data may be used as synchronized stream. What can be provided in the synchronized stream data is past playing scenes or interview scenes that are provided as moving picture when a particular player appears in a sport
25 game.

The synchronized data are presented in connection with other basic stream composing a video/audio program. So, they

provide information related to a particular scene. This is different from the services using asynchronous data.

Technologies for providing synchronized data services are being developed in the inside and outside of the country. Among them, Data Interface Working Group (DIWG), which is an embodiment work group of Advanced Television System Committee (ATSC), is a representative one.

DIWG has presented a system model formed of various functional modules to embody a synchronized data broadcasting system. However, since the system model includes a function that a module encoding video/audio data into an MPEG-2 transport stream multiplexes additional data simultaneously, it has a problem that it is not compatible with conventional digital broadcasting apparatuses which multiplex video/audio data only.

In addition, since the system suggested by DIWG is for synchronized non-stream data, it has another problem that it could not provide a service of synchronized stream data.

Meanwhile, the synchronized data are presented at a moment presentation time stamp of the synchronized data is coincided with the reference time of the receiver, which is a system time clock (STC). Synchronized non-stream data are presented only once at a particular time point. So, if the synchronized non-stream data arrives in the receiver before the value of STC becomes equal to the presentation time stamp of the synchronized non-stream data, the data may be presented in the receiver without any problem. The synchronized stream

data includes successive DAU and each DAU has its own presentation time stamp. Buffer models for the synchronized stream data are defined for the receiver to present the DAU successively and smoothly. However, the defined receiver
5 buffer models may cause buffer overflow due to the other DAU existing in the buffer, when the DAU arrives in the receiver too quickly, and thus brings about data loss. Therefore, the synchronized stream data should be outputted in consideration of whether DAU has arrived in the receiver.

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Summary of the Invention

It is, therefore, an object of the present invention to provide an apparatus and method for injecting synchronized
15 stream data for a digital data broadcasting service, the apparatus and method calculating an injection time point with respect to each data access unit (DAU) which forms synchronized stream data so that the synchronized stream data could be presented in a receiver smoothly, and injecting the
20 DAU into a Moving Picture Experts Group 2 (MPEG-2) audio/video transport stream at the calculated injection time point.

In accordance with an aspect of the present invention, there is provided an apparatus for injecting synchronized stream data for a digital data broadcasting service,
25 including: an additional data storing unit for storing, managing and outputting additional data used for the digital data broadcasting service; a synchronized stream data

selection/establishment unit for selecting synchronized stream data to be multiplexed with a video/audio transport stream, which is inputted from the outside, among the additional data stored in the additional data storing unit, and establishing
5 parameter values necessary to multiplex the selected synchronized stream data and the video/audio transport stream; a synchronized stream data analyzing unit for analyzing the selected synchronized stream data periodically based on the parameter values established in the synchronized stream data
10 selection/establishment unit, and generating information related to the transport stream of the synchronized stream data; a transport stream analyzing unit for analyzing the video/audio transport stream periodically based on the parameter values established in the synchronized stream data
15 selection/establishment unit, and generating information related to the video/audio transport stream; a synchronized stream data injection/management unit for determining whether to inject a data access unit (DAU) that forms the synchronized stream data or not based on the information related to the
20 synchronized stream data transport stream generated in the synchronized stream data analyzing unit and the information related to the video/audio transport stream generated in the transport stream analyzing unit, and controlling the output of the DAU that forms the synchronized stream data which are
25 stored in the additional data storing unit; a presentation time stamp re-stamping unit for re-stamping the presentation time stamp of the synchronized stream data which are outputted

from the additional data storing unit based on the parameter values established in the synchronized stream data selection/establishment unit; and a multiplexing unit for multiplexing and outputting the video/audio transport stream and the synchronized data outputted from the presentation time stamp re-stamping unit.

In accordance with another aspect of the present invention, there is provided a method for injecting synchronized stream data for a digital data broadcasting service, including the steps of: a) selecting synchronized stream data that are synchronized with a video/audio transport stream supplied from the outside among additional data used for the digital data broadcasting service, and establishing an injection period which is a time interval for analyzing the video/audio transport stream and the synchronized stream data and injecting the synchronized stream data, the number of analyzed DAU which is the largest number of DAU that can be injected into the video/audio transport stream during the above established injection period, and a new presentation time stamp of a first data access unit (DAU) of the synchronized stream data; b) obtaining the presentation time stamp of a corresponding DAU and the number of transport stream packets by analyzing the selected synchronized stream data periodically based on the injection period and the number of analyzed DAU which are established in the step a), and obtaining as many DAU as the analyzed DAU; c) obtaining PCR information of the video/audio transport stream within the

analyzing section by analyzing the video/audio transport stream periodically based on the injection period determined in the step a); d) determining whether to inject the DAU of the synchronized stream data into the video/audio transport stream within the analyzing section or not based on the new presentation time stamp of the first DAU of the synchronized stream data, presentation time stamp of DAU of the synchronized stream data and the PCR information of the video/audio transport stream; e) if the DAU of the synchronized stream data is to be injected into the video/audio transport stream within the analyzing section, re-stamping the presentation time stamp of DAU of the synchronized stream data by using the new presentation time stamp of the first DAU of the synchronized stream data; and f) injecting the DAU of the synchronized stream data whose presentation time stamp is re-stamped newly into the video/audio transport stream and outputting the video/audio transport stream with the DAU.

Brief Description of the Drawings

The above and other objects and features of the present invention will become apparent from the following description of the preferred embodiments given in conjunction with the accompanying drawings, in which:

Fig. 1 is a block diagram illustrating a digital data broadcasting system to which the technology of the present

invention is applied;

Fig. 2 is a block diagram describing a synchronized data injecting block 400 in accordance with an embodiment of the present invention;

5 Fig. 3 is a flow chart describing a synchronized stream data injecting process of the synchronized data injecting block 400 in accordance with an embodiment of the present invention; and

10 Fig. 4 is a flow chart further describing a process for re-stamping the presentation time stamp of additional data in the synchronized stream data injecting process in accordance with an embodiment of the present invention.

Detailed Description of the Invention

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Other objects and aspects of the invention will become apparent from the following description of the embodiments with reference to the accompanying drawings, which is set forth hereinafter.

20 Fig. 1 is a block diagram illustrating a digital data broadcasting system to which the technology of the present invention is applied. As shown in the drawing, the digital data broadcasting system, to which the present invention is applied, includes: a video/audio storage 100, a video/audio
25 encoding block 200, a program multiplexing block (PMUX) 300, a synchronized stream data injecting block 400, a Program and System Information Protocol (PSIP)/Service Information (SI)

generating block 500 and a re-multiplexing block 600.

The video/audio storage 100 stores and manages a predetermined size of video/audio data transmitted from the outside.

5 The video/audio encoding block 200 performs encoding of the video/audio data transmitted from the video/audio storage 100 based on Moving Picture Experts Group 2 (MPEG-2) standards.

10 The program multiplexing block (PMUX) 300 packetizes the MPEG-2 video/audio elementary stream (ES) transmitted from the video/audio encoding block 200 into a packetized elementary stream (PES). The PMUX 300 also generates program specific information (PSI) or service information (SI) of the PES and converts them into transport stream packets.

15 The synchronized stream data injecting block 400 selects synchronized stream data, which are synchronized with the MPEG-2 video/audio transport stream, among the additional data in the synchronized stream data injecting block 400, and injects the synchronized stream data into the video/audio transport stream and outputs it.

20 The PSIP/SI generating block 500 generates, manages and outputs program guidance information (PSIP table or SI table) of an Advanced Television Systems Committee (ATSC) standards or Digital Video Broadcasting (DVB) standards in order to guide the programs of a digital data broadcasting service.

25 The re-multiplexing block 600 abstracts and re-constructs PSIP/SI/PSI of several transport streams, which are transmitted from the synchronized stream data injecting block

400 and PSIP/SI generating block 500. If necessary, it can give a packet identifier (PID). In addition, it can output a corresponding transport stream by adjusting program clock reference (PCR).

5 Referring to Fig. 2, the structure of the synchronized stream data injecting block 400 of the present invention will be described herein in a digital broadcasting system having the above-described structure.

Fig. 2 is a block diagram describing a synchronized data
10 injecting block 400 in accordance with an embodiment of the present invention. As illustrated in the drawing, the synchronized data injecting block 400 of the present invention includes: an additional data storing unit 440, a synchronized stream data selection/establishment unit 410, a synchronized
15 stream data injection/management unit 420, a synchronized stream data analyzing unit 430, a transport stream analyzing unit 450, a presentation time stamp re-stamping unit 460 and a multiplexing unit 470.

The additional data storing unit 440 stores, manages and
20 outputs additional data including the synchronized stream data which is encapsulated in the form of an MPEG-2 transport stream that are used in a digital data broadcasting service. Here, the output time point of the synchronized stream data which are stored in the additional data storing unit 440 is
25 determined based on a control signal transmitted from the synchronized stream data injection/management unit 420.

The synchronized stream data selection/establishment unit

410 selects synchronized stream data which are synchronized with a video/audio transport stream inputted from the outside among the additional data stored in the additional data storing unit 440. Also, the synchronized stream data selection/establishment unit 410 establishes the values of parameters, such as an injection period, which is time interval for injecting synchronized stream data into a video/audio transport stream, a new presentation time stamp of a first DAU of the selected synchronized stream data, and the number of analyzed DAU, which means the maximum number of DAU of synchronized stream data that can be injected in one injection period. The synchronized stream data analyzing unit 430 obtains as many DAU as the number of analyzed DAU by analyzing the synchronized stream data selected based on the injection period and the number of analyzed DAU that are established in the additional data selection/establishment unit 410, and generates information related to the synchronized stream data, such as the presentation time stamp of a corresponding DAU, and the number of transport stream packets.

The transport stream analyzing unit 450 analyzes video/audio transport stream periodically based on the injection period established in the additional data selection/establishment unit 410, and generates information related to the video/audio transport stream, such as PCR of video/audio transport stream. Here, the PCR value of transport stream can be obtained directly from a transport

stream including PCR within the analysis section, and PCR for another transport stream packet is calculated based on the output rate of MPEG-2 transport stream. Otherwise, PCR values can be obtained by putting a reference clock that increases at 27MHz which is the same as the per-second increase of PCR in the transport stream analyzing unit 450, obtaining PCR from a transport stream packet including PCR among the inputted MPEG-2 transport streams, establishing as the reference clock the same value as the obtained PCR, and obtaining the value of the reference clock at a necessary moment.

The synchronized stream data injection/management unit 420 calculates the presentation time offset value by using the difference between the new presentation time stamp of a first DAU of the synchronized stream data and the presentation time stamp of a first DAU of the synchronized stream data obtained in the synchronized stream data analyzing unit 430, calculates a new presentation time stamp of DAU of the synchronized stream data by adding the presentation time offset value to the presentation time stamp of DAU of the synchronized stream data obtained in the synchronized stream data analyzing unit 430, and compares it with the PCR, which is generated periodically based on the injection periods established in the additional data selection/establishment unit 410, in the transport stream analyzing unit 450. If the new presentation time stamp of DAU is larger than PCR_base of the final part of the video/audio transport stream currently analyzed and smaller than a value obtained by adding the increase of

PCR_base that increases during a period to PCR_base of the final part, it is determined as a time point for injecting DAU and a corresponding DAU is controlled to be outputted from the additional data storing unit 440.

5 Here, the increase of PCR_base increasing for one period can be calculated as shown in Fig. 1 by using the per-second increase of PCR_base, i.e., 90,000, and the injection period established in the additional data selection/establishment unit 410.

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$$\text{PCR_base increase during a period} = \text{injection period} \times 90,000$$

Eq. 1

15 When a new presentation time stamp is stamped for the synchronized stream data in the synchronized stream data selection/establishment unit 410, the presentation time stamp re-stamping unit 460 re-stamps the presentation time stamp of the synchronized stream data into the new presentation time stamp.

20 The multiplexing unit 470 injects DAU of the synchronized stream data, which are outputted from the presentation time stamp re-stamping unit 460, into the video/audio transport stream outputted from the transport stream analyzing unit 450.

25 Referring to Fig. 3, the operation of the synchronized stream data injecting block 400 having the above-described structure will be described hereinafter.

Fig. 3 is a flow chart describing a synchronized stream data injecting process of the synchronized stream data injecting block 400 in accordance with an embodiment of the present invention. As illustrated in the drawing, at step S310, the synchronized stream data selection/establishment unit 410 of the synchronized stream data injecting block 400 selects synchronized stream data that are synchronized with the video/audio transport stream inputted from the outside among the additional data stored in the additional data storing unit 440.

Also, it establishes the values of parameters, such as an injection period, which is time interval for injecting synchronized stream data into a video/audio transport stream, a new presentation time stamp of a first DAU of the above-selected synchronized stream data, and the number of analyzed DAU, which means the maximum number of DAU of synchronized stream data that can be injected in one injection period. Here, if the number of analyzed DAU is not established, it is calculated by multiplying the largest value (59.94 or 60) of the number of frequency of DAU generation to the established injection period. If both injection period and the number of analyzed DAU are not established, the injection period is set to be 50msec and the number of analyzed DAU is determined to be 3.

Subsequently, at step S320, the synchronized stream data analyzing unit 430 analyzes the synchronized stream data selected in the additional data selection/establishment unit

410 based on the injection period and the number of analyzed
DAU, which are established in the additional data
selection/establishment unit 410, periodically to obtain as
many DAU as the number of analyzed DAU, and generates
5 information related to synchronized stream data, such as
presentation time stamp of a corresponding DAU, the number
transport stream packets.

Subsequently, at step S330, the transport stream
analyzing unit 450 periodically analyzes the video/audio
10 transport stream inputted from the outside in real-time based
on the injection period established in the additional data
selection/establishment unit 410, and generates information
needed to inject the synchronized stream data, such as PCR of
the video/audio transport stream within the analysis section.

15 Subsequently, at step S340, it is determined whether it
is a section for injecting DAUs of a synchronized stream data.
The synchronized stream data injection/management unit 420
calculates a presentation time offset by using the difference
between a new presentation time stamp of a first DAU of the
20 synchronized stream data established in the additional data
selection/establishment unit 410 and the presentation time
stamp of a first DAU of the synchronized stream data obtained
in the synchronized stream data analyzing unit 430.

Then, the synchronized stream data injection/management
25 unit 420 calculates a new presentation time stamp of DAU of
the synchronized stream data obtained in the synchronized
stream data analyzing unit 430. It determines whether to

inject DAU of the synchronized stream data into the video/audio transport stream within the analysis section by comparing the new presentation time stamp calculated above with PCR obtained from the analysis of the video/audio transport stream. If the DAU of the synchronized stream data is determined for injection, synchronized stream data injection/management unit 420 controls the additional data storing unit 440 to output corresponding DAU.

Subsequently, at step S350, if a new presentation time stamp is established with respect to a first DAU of synchronized stream data in the synchronized stream data selection/establishment unit 410, the presentation time stamp re-stamping unit 460 re-stamps the presentation time stamp of DAU that forms synchronized stream data outputted from the additional data storing unit 440 based on the control of the synchronized stream data injection/management unit 420, by referring to the presentation time stamp newly stamped in the synchronized stream data selection/establishment unit 410. If the DAU of the synchronized stream data is not injected, process goes back to the step S320.

Here, to re-stamp the presentation time stamp of all DAU that form synchronized stream data, a presentation time offset value is calculated by using the difference between the presentation time stamp of the first DAU of the synchronized stream data and the new presentation time stamp stamped in the synchronized stream data selection/establishment unit 410. Here, the summation of the presentation time stamp of the

first DAU of the synchronized stream data and the calculated presentation time offset value should be equal to the new presentation time stamp.

5 The presentation time stamp of all DAU that forms the synchronized stream data is re-stamped by adding the presentation time offset value to the presentation time stamp of all DAU of the synchronized stream data.

10 Subsequently, at step S360, the multiplexing unit 470 injects the DAU of the synchronized stream data outputted from the presentation time stamp re-stamping unit 460 into the video/audio transport stream outputted from the transport stream analyzing unit 450 and outputs one transport stream.

15 At step 370, it is determined whether all of DAUs are injected or not. If all of DAUs are not injected, i.e., is there any DAU to be injected, process continues to the step S320.

20 Fig. 4 is a flow chart further describing a process (S350) for re-stamping the presentation time stamp of additional data in the synchronized stream data injecting process in accordance with an embodiment of the present invention.

25 First, to re-stamp the presentation time stamp of DAU that forms synchronized stream data, at step S351, it is checked if a new presentation time stamp of a first DAU of synchronized stream data is stamped through the synchronized stream data selection/establishment unit 410.

If a new presentation time stamp of the first DAU of the

synchronized stream data is not stamped, the presentation time stamp re-stamping process is terminated, and if a new presentation time stamp is stamped, at step S352, the presentation time offset value is calculated. The presentation time offset value of the synchronized stream data can be obtained by subtracting the actual presentation time stamp the first DAU of the synchronized stream data from the newly stamped presentation time stamp of the first DAU of the synchronized stream data, as shown in below Equation 2.

$$\begin{aligned} \text{presentation time offset (PTS}_{\text{off}}) = \\ \text{new presentation time stamp} - \text{presentation time stamp of} \\ \text{a first DAU} \end{aligned}$$

Eq. 2

When the presentation time offset of the synchronized stream data is calculated, at step S353, the re-stamped presentation time stamp of each DAU that forms the synchronized stream data is calculated and re-stamped. The re-stamped presentation time stamp of DAU that forms synchronized stream data can be calculated by adding the presentation time offset to the presentation time stamp of all DAU that form the synchronized stream data, as shown in Equation 3.

$$\begin{aligned} \text{Re-stamped presentation time stamp of DAU} = \\ \text{Presentation time stamp of a DAU} + \text{PTS}_{\text{off}} \end{aligned}$$

Eq. 3

5 As described above, the present invention discloses an
apparatus for injecting synchronized stream data, which is a
stream data synchronized with audio/video data temporally,
into an MPEG-2 video/audio transport stream. This technology
can be used to establish a digital data broadcasting system
that can provide a synchronized stream data service, which is
10 capable of providing more diverse data service to viewers.

 While the present invention has been described with
respect to certain preferred embodiments, it will be apparent
to those skilled in the art that various changes and
modifications may be made without departing from the scope of
15 the invention as defined in the following claims.